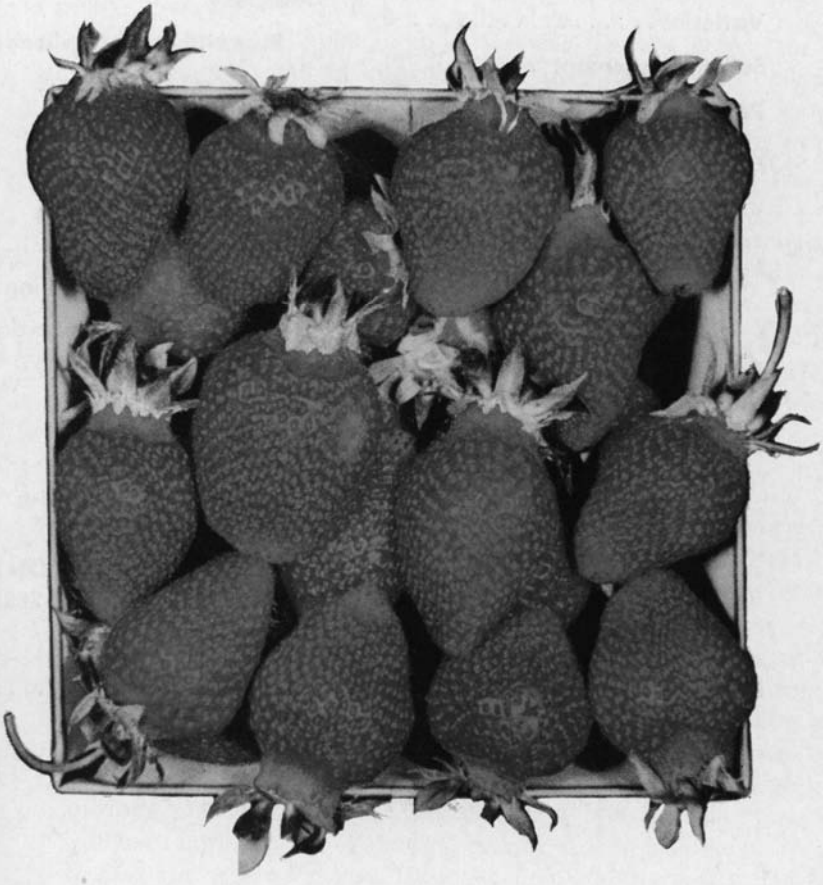
# *Strawberry Growing in Illinois*

BY CHESTER C. ZYCH AND DWIGHT POWELL



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# Strawberry Growing in Illinois

By Chester C. Zych and Dwight Powell[1]

## PART I—CULTURE

Strawberries have been an important horticultural crop in Illinois for many years. They are grown successfully in all parts of the state either commercially or in home gardens. In comparison with other Illinois fruits, strawberries are exceeded in commercial value only by apples and peaches.

Approximately 3,000 acres of strawberries are grown for market in Illinois, with a total crop value of over one million dollars. The current center of commercial strawberry production in the state is the Centralia-Irvington area where an estimated 1,500 acres are in production. Lesser acreages are found in the Cobden-Anna area and in Franklin county around West Frankfort. Additional plantings ranging in size from 1 acre to 40 acres or more are scattered throughout the state, with the heaviest concentrations near the larger towns and cities.

Commercial strawberry production on either a small acreage or on 40 acres or more is not a simple operation. If the enterprise is to be successful, the grower must observe the basic principles of strawberry culture, for profitable strawberry production is impossible when yields are low.

### YIELDS AND COSTS

There are so many circumstances connected with strawberry growing that yields and production costs vary considerably and are hard to appraise. Varieties, soil, climate, location, markets, and the skill of the grower all influence yields and costs.

Many of the better growers harvest 5,000 to 6,000 quarts an acre regularly. Occasionally yields up to 10,000 quarts an acre may be obtained under the best conditions, particularly when irrigation is used.

Since production costs per acre are high for strawberries in comparison with the costs of many other crops, yields must be high in order to make substantial profits. In general, the cost from the time the site is chosen until the end of the first picking season may range from $400 to $600 an acre. The cost from the first-year harvest to the second-year harvest may amount to $150 to $200 an acre.

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**Sound management practices result in good stands like this, which are necessary to obtain high yields and worthwhile profits. (Fig. 1)**

Successful strawberry growers do not jump in and out of the business. They have some patches in bearing every year and have other patches newly planted for the next year's crop so that over a period of years, they have a profitable business.

## LOCATION

The prospective commercial strawberry grower should have in mind a few important details about choosing a location, for although the selection of a good location is not a guarantee of success, continued success is seldom obtained without it.

**Markets.** A very important factor to be considered is nearness to a market or some good shipping point. In general, the importance of possible market outlets becomes greater as the size of the planting increases. The larger Illinois towns and cities provide ready markets for strawberries within easy trucking or rail distances. Trucking has

become a commonly used means of transporting strawberries during recent years, with service frequently available directly from the strawberry patch. In concentrated production areas, rail service may be used to advantage. However, in order to benefit from carlot shipments, a minimum of 75 to 100 acres conveniently located around the shipping point is required to load one car daily. In some areas, transportation may not be an important factor, particularly where a well-located roadside market provides a convenient and profitable means of disposing of a high-quality crop.

Locations within 15 to 20 miles of large cities are suitable for marketing berries by the "pick-your-own" method. Most growers who have tried this method have been pleased with the results, in some instances receiving more for their fruit than through conventional harvesting methods. Productive, well-cared-for plantings are a must to command premium prices with this type of marketing.

**Sites.** Water and air drainage, direction and amount of slope, and soil type are important factors to consider in selecting the site. The greatest advantage to having a site with a little elevation to it is that the slope helps provide water drainage. For although plenty of moisture is desirable, standing water is definitely harmful. Strawberry plants are weakened by being under water for even a few hours. Therefore avoid waterlogged or puddled soils. Such conditions also favor leaching and the development of destructive root diseases. If the only land available is low and poorly drained, grow the plants on slightly raised ridges. Varieties resistant to the red stele disease are preferable under these conditions.

Slope is also a highly desirable feature in a site because it provides air drainage. Cold air, like water, normally flows downhill and collects in low places. Therefore if spring frosts are likely to occur during blossoming, it is an advantage to have a slightly elevated site so that the cold air will drain to a lower spot. A gentle slope falling 2 to 3 feet per hundred is adequate. Other measures, such as mulch or sprinkler irrigation, are necessary to protect the blossoms from a severe or prolonged cold snap. These also make it possible to protect fertile bottom land sites from late spring frosts (see "Preventing Spring Frost Injury," page 32).

The direction of slope should also be considered because of its influence on spring plant growth. Fruit grown on a southern slope matures as much as nine days before fruit grown on a slope that faces north. However, since the plants on a south slope blossom earlier,

there is a greater risk of frost damage to blossoms. Here again, some means of frost protection may be utilized in order to produce early market berries. With such protection available, a grower can plant on both early and late slopes for a longer harvest period.

Since strawberries are cultivated intensively during the first year, gentle slopes are preferable to steep ones. Slopes up to 20 percent are usable by planting on the contour with or without terraces. It is a good practice to plant on the contour on sites with a slope of 5 percent or more (Fig. 2).

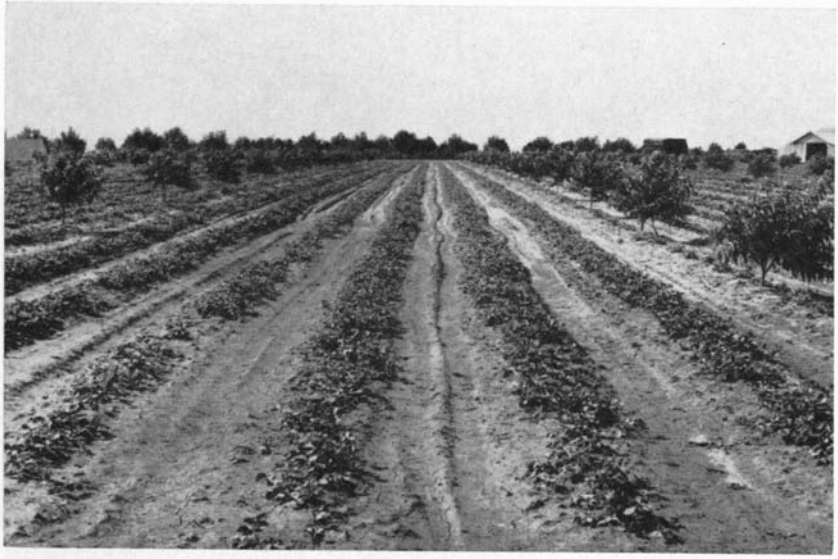
The soil factor too is decidedly important because, although strawberries will grow on a wide range of soil types, the best yields are obtained on deep, fertile, well-drained soils of high water-holding capacity. This does not mean, however, that light sandy soils or heavy clay soils are not capable of giving good results when properly managed. Heavy applications of manure or the plowing under of green-manure crops will improve the structure of both types of soils. Sandy soils also require large quantities of commercial fertilizers and the installation of irrigation equipment for maximum yields. Whenever the choice of a site is limited to the less desirable soil types or to

**Sloping sites are desirable for strawberries since they permit good water and air drainage. It is a good practice, however, to plant on the contour on sites with a slope of 5 percent or more. (Fig. 2)**

newly cleared ground, it is highly desirable to begin soil preparation at least the fall before planting and preferable to begin it a year or two ahead of planting strawberries (see "Soil Management," page 11).

## INTERCROPPING

Strawberries are sometimes planted as intercrops in young orchards. The berries occupy the land for only a few years and bear fruit the year after planting, thus furnishing an income while the orchard is becoming established. There are objections to this practice: the straw mulch is a fire hazard, sometimes harbors mice which may attack the trees, and causes a reduction in the nitrogen available to the trees; orchard operations are more difficult; and cultivation times for the crops differ. If strawberries are used as an intercrop, it is a good practice to plant only a few rows between tree rows (Fig. 3), leaving adequate space on either side of the tree rows to cultivate or disk. Do not set the plants within six feet of the spread of the branches. Then you can cultivate the strawberries late in the fall when the fruit trees shouldn't be cultivated and can cultivate the trees in the spring when the strawberries are still under mulch. Apply extra fertilizers



The strawberries growing in this young peach orchard are a supplement to the grower's income while the trees reach bearing age. *(Courtesy J. W. Courter, Department of Horticulture, University of Illinois)* (Fig. 3)

to the trees, use a good mouse-control program, and don't leave the strawberries in longer than two or three harvest seasons.

Intercropping of strawberries with vegetables is not recommended since this practice seldom results in a good planting of strawberries.

## VARIETIES

Since the beginning of the commercial strawberry growing industry in the United States in the early 1800's, thousands of strawberry varieties have been named and introduced. New varieties are introduced each year, and some of them seriously challenge the position of the older established varieties. Generally speaking, strawberry varieties are rather exacting in their response to temperature, day length, and soil fertility. Therefore each variety is usually best suited to a particular region. Varieties such as Florida Ninety and Missionary need little or no rest period and are thus adapted to the Southern States; whereas most northern varieties require temperatures below 45° F. to break the rest period. The fact that a variety succeeds in a certain

**The testing of new varieties and selections in plots such as this is carried on at Urbana, Carbondale, and Dixon Springs. (Fig. 4)**

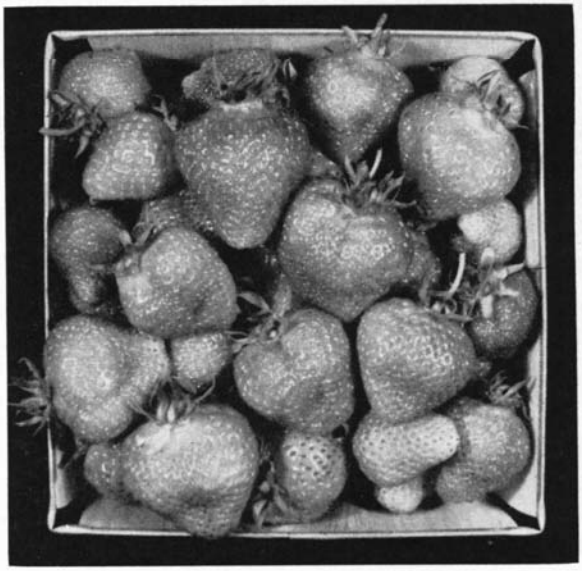
**Vermilion, originated by the Illinois Agricultural Experiment Station, is an early-midseason variety that is resistant to the common strain of the red stele root rot organism in Illinois. The berries are very attractive and of high dessert quality, medium firm, but only fair for freezing. It is a good producer from Urbana northward. (Fig. 5)**

area is no assurance that it will thrive elsewhere; even different sites on the same farm may affect the performance of a particular variety.

New varieties are being tested at the Illinois Agricultural Experiment Station for their adaptability to some of the different soils and to the different latitudes in the state (Fig. 4). However, it is practically impossible to test varieties for their adaptability to all the various soil types found throughout the state. Therefore if a grower is interested, he should test new varieties in small plots (at least 25 plants of each variety) for at least two years to determine their adaptability to his environmental and cultural conditions.

When selecting a variety or varieties for the main commercial crop, every grower should keep in mind whether he means to sell on the local market, to ship, or to sell for processing. For local market production, select varieties that have high quality and a long ripening season or else grow several varieties that ripen in succession. Berries to be shipped must be firm enough to withstand the additional handling and transportation. Fruit for processing should be medium and uniform in size, easy to hull, red throughout, and highly flavored.

Dixieland is a promising new variety for commercial strawberry growers in Illinois. The fruit matures about the same time as Blakemore but is larger and the plants are generally more productive. Leaf scorch is sometimes severe. (Fig. 6)



Earlidawn is worthy of trial as an early variety. It appears to be as blossom-hardy to frosts as Howard Premier. (Fig. 7)

**Table 1. — Strawberry Varieties Suggested for Commercial Planting in Illinois**

| Variety | Season | Firmness | Resistant (R) or susceptible (S) to red stele | Fruit size | Freezing value | Remarks |
|---|---|---|---|---|---|---|
| Armore | Late | Medium | S | Large | Fair | Subject to mildew and leaf spot |
| Blakemore | Early | Firm | S | Small | Good | Southern Illinois only |
| Catskill | Early midseason | Soft | S | Large | Good | Local market |
| Dixieland | Early | Firm | S | Large | Very good | Subject to leaf scorch |
| Earlidawn[a] | Very early | Medium | S | Large | Good | Blossoms hardy to frosts |
| Empire | Midseason | Soft | S | Large | Poor | Northern Illinois only |
| Howard Premier | Early | Soft | S | Medium | Poor | Local market |
| Pocahontas | Early midseason | Medium | S | Large | Very good | Good all-purpose variety |
| Robinson | Late | Soft | S | Large | Poor | Local market |
| Sparkle | Late | Medium | R | Medium | Very good | Northern Illinois only |
| Surecrop[a] | Early midseason | Medium | R | Medium | Good | Red stele areas |
| Tennessee Beauty | Late | Firm | S | Medium | Very good | Caps easily |
| Vermilion | Early midseason | Medium | R | Large | Fair | Northern Illinois only |

[a] Newer varieties for trial only.

The resistance of varieties to disease is important too, since the control of disease is a needless expense if suitable resistant varieties are available. Disease resistance is especially important for the control of diseases like the red stele root rot for which no chemical controls are available.

It is important to include only two or three varieties when strawberries are being raised for the general market since buyers usually prefer to have full carloads or truckloads of the same variety rather than mixed loads which may differ in firmness or other important characteristics. Larger commercial plantings are usually limited to three varieties that mature in succession, thus extending the harvest season. The use of more than one variety also offers a form of insurance in areas where spring frosts may kill the blossoms of one variety while those of a variety that blooms later may escape injury.

Some representative strawberry varieties for Illinois are given in Table 1 together with some of their more important characteristics. Three of these are shown in Figs. 5, 6, and 7. Detailed descriptions of these and other varieties may be obtained by writing to the Department of Horticulture, University of Illinois, Urbana, Illinois.

## SOIL MANAGEMENT

Land which previously has been in cultivation is to be preferred for a new strawberry planting over land which has been in sod for some years. Growing a cultivated crop for at least one year reduces weed and root-feeding insect problems and improves the physical properties of the soil. However, strawberries should not follow any of

the solanaceous crops (potatoes, tomatoes, peppers, or eggplants) because of the susceptibility of these crops to the Verticillium wilt fungus, which may contaminate the soil and seriously damage the strawberries (see page 53).

If corn precedes strawberries, the land should be treated for root aphids because they will cause damage if present in sufficient numbers. Apply 10 pounds of actual chlordane per acre before setting the plants (the percentage of actual insecticide mixed with the carrier is indicated on the container). Dieldrin or aldrin at 5 pounds, actual, per acre is also effective against the common soil insects attacking strawberries. Apply any one of these materials as a spray, dust, or in granular form to the surface of the soil and disk immediately to work it into the top four inches of soil. Some fertilizer manufacturers are incorporating soil insecticides in their fertilizer mixtures, thus making it possible to fertilize and apply the soil insecticide in one operation. If such a combination is used, make sure you apply the necessary amount of actual insecticide.

If properly treated, sod land may be used for a new strawberry planting. Destroy the grass sod during the fall before planting by spraying with dalapon at the rate of 10 to 20 pounds an acre about one week before plowing. The grass should be actively growing when dalapon is applied. If it is low in vigor, fertilize with about 30 pounds of actual nitrogen per acre two weeks before applying the dalapon. Strawberries may then be planted the following spring after the soil has been suitably prepared and has been treated with one of the soil insecticides mentioned above.

The soil should contain abundant quantities of humus (decaying vegetable matter) when the plants are set. This may be supplied either by applying 10 to 30 tons an acre of manure the fall before planting, or by growing and turning under one or more green-manure crops the year before the plants are set. The legume crops — sweet clover, vetch, beans, peas, and, in the southern part of the state, Korean lespedeza — may be used for this purpose. The suggested seeding rates an acre for these crops are as follows: sweet clover, 10 to 12 pounds; vetch, 20 pounds; soybeans, 1½ bushels; cowpeas, 1 bushel; lespedeza, 15 to 20 pounds. A mixture of one of the above summer legumes with a bushel of oats and a peck of buckwheat may also be used. An excellent combination for a light sandy soil is a bushel of rye and 20 pounds of vetch. This combination may be sown as late as August. The fall growth of the vetch and rye may be small, but good growth will begin in the spring. Plow the crop under when the vetch is in full bloom.

Fall plowing is to be preferred over spring plowing unless serious damage from erosion is apt to result. Preparation in the spring may require only leveling with a harrow after the settling effect of the winter. Disking is usually necessary, however, followed by a smoothing harrow and a corrugated roller or a "planker" to break up the clods and to compact the soil before the rows are marked. Where planting on ridges is necessary because of slow drainage, a lister may be used to throw up ridges 3 to 12 inches above the furrows that separate them.

## ROTATIONS

Large-scale growers should put strawberries in rotation with other crops for success over a period of years. A good rule to follow is to grow other row crops and green-manure crops for at least as long a period as the strawberries. Some growers have profitably maintained a strawberry planting for 5 years or more but usually plantings are kept for only 2 or 3 harvest seasons, after which the yields become unprofitable because of a reduction in soil fertility and a buildup of diseases, insects, and weeds.

## PLANTS AND PLANTING

The health of the runners used for starting a strawberry planting is of vital importance if success is to be achieved. A new planting usually should not be started from an old one because almost all established plantings are heavily infested with virus diseases. In most instances it is far better and cheaper to obtain virus-free plants from a dependable nursery than to risk using plants of doubtful value.

### Obtaining Plants

Select young plants from an old patch only if they do not show any evidence of insects or diseases. Clean the soil away from the roots so that no insects or other infectious materials are carried along when the plants are transplanted. Usually growers who wish to use their own stock grow several rows just for that purpose. These rows are kept separate from the main plantings. Inspect such plantings periodically during the growing season to remove any weak or abnormal plants, and when the plants are dug for planting, use only those with large, light-colored root systems and large crowns. Much depends upon the season and the variety, but growers may expect to produce from 6 to 25 good strawberry plants per foot of row.

Growers who feel that the cost and inconvenience of growing and digging their own plants are so great as to make nursery plants more economical should order their plants early, just as soon as the new nursery catalogs are received. Early orders provide a better chance of receiving good plants and a full order. Order only virus-free plants from a reputable nursery, specifying the latest date of shipment for arrival in ample time for earliest possible planting.

## Number of Plants Needed

The number of plants needed to set an acre varies according to how the plants are spaced. In the matted-row system, as used by most Illinois commercial growers, the plants are set 1½ to 2 feet apart in rows 3½ to 4 feet apart (Table 2). The number of plants required to set an acre in other systems may be computed by first determining how many square feet must be allowed per plant and then dividing that figure into 43,560, which is the number of square feet in an acre. For example, if, under the hill system, plants are 1 foot apart in a row, rows are 1 foot apart, and a 2-foot aisle separates each set of four rows, then 5 square feet must be allowed for every 4 plants or 1¼ square feet per plant. Dividing 1¼ into 43,560 shows that 34,848 plants are required to set one acre under this system. Additional plants should be ordered to allow for some discard and for resetting.

**Table 2. — Number of Plants Needed to Set an Acre When Spaced at Different Distances**

| Spacing | | Plants to the acre |
|---|---|---|
| In the row | Between rows | |
| *feet* | *feet* | *number* |
| 1 | 3 | 14,520 |
| 1 | 3½ | 12,446 |
| 1 | 4 | 10,890 |
| 1½ | 3 | 9,680 |
| 1½ | 3½ | 8,296 |
| 1½ | 4 | 7,260 |
| 2 | 3 | 7,260 |
| 2 | 3½ | 6,223 |
| 2 | 4 | 5,445 |
| 2½ | 3 | 5,810 |
| 2½ | 3½ | 4,980 |
| 2½ | 4 | 4,356 |
| 3 | 3 | 4,840 |
| 3 | 3½ | 4,148 |
| 3 | 4 | 3,630 |

## Caring for Plants

Treatment of the plants after they are received from a nursery depends upon the time elapsing between arrival and setting and on the storage facilities that are available to the grower. The package should be opened as soon as it arrives and be inspected for the condition of the plants and for their variety and number. Any discrepancy should be reported to the nursery immediately. If setting is planned for the day that the package arrives, or for the day after, then store the plants in a cool place and keep them moist.

If planting must be delayed for several days, the plants should be placed in cold storage or else heeled in or trenched (Fig. 8) in a well-drained spot which is protected from the sun and wind. Plants stored at 28° to 32° F. in plastic bags or in damp peat moss or sawdust to maintain high humidity grow better than those that have been heeled in. Though temperatures from 28° to 32° F. are best, the range of 28° to 40° F. has been satisfactory.

When heeling in strawberry plants, dig a V-shaped trench 6 inches deep. Open the bundles and spread the plants one deep on one side of the trench with the crowns just above the ground as in planting. Cover the roots with soil, firm the soil, and water well. If there is much delay before planting, water when necessary and make sure that the roots are covered to the crown level at all times. *(Courtesy U. S. Department of Agriculture)* (Fig. 8)

## Setting the Plants

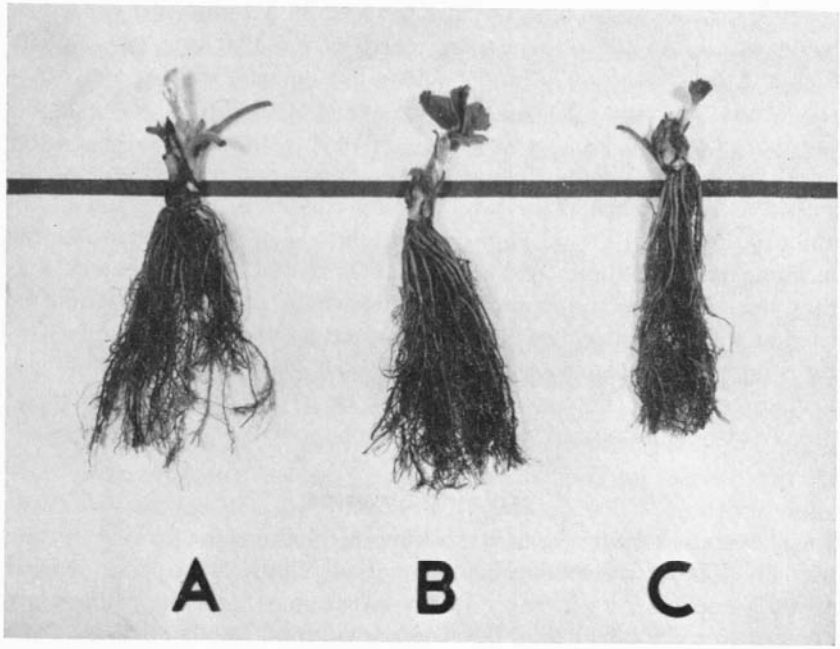
Strawberries should be planted as early as possible in the spring. Early planting allows the plants to become well established before hot, dry weather comes. It also produces more early runners, which is desirable because they bear much more fruit than the ones formed later. Fall planting is not a good practice for commercial growers. Fall-set plants require extra care in weed control, and they require mulching to prevent injury from heaving during the winter. Weather and soil conditions are also more favorable for plant growth in the spring than in the fall.

If possible, the plants should be set during cloudy weather or during late afternoon or evening. Every precaution should be used to keep the roots moist while the plants are being handled. Keep the main supply of plants in a shady spot. Also, keep them either wrapped in plastic sheets or in several layers of moist cloth, or keep them stored in partly filled tubs of water. Plants that are being dropped in the row may be carried in a carpenter's apron lined with polyethylene or in a bucket partly filled with water.

The success of a strawberry planting depends largely on the manner in which the plants are set in the ground. Regardless of the method used, two points are of special importance: set the plants at the correct depth and pack the soil firmly around the roots. Strawberries are rather exacting about the depth at which they must be planted. Therefore set them so that the crowns are even with the surface of the ground after the soil has been firmed around the roots (Fig. 9). If the crown is set too shallow, it will dry out, and if set too deep, it may be smothered. Fan the roots out slightly while inserting the plant into the soil, and pack the soil firmly enough so that a quick upward pull on a leaf stem will result in breaking the stem rather than in uprooting the plant. In order to pack the soil firmly, some growers step on each plant after it is set. If this is done, the instep should be over the crown of the plant to avoid injury.

Three methods are in common use for setting the plants: (1) machine transplanter; (2) two persons working with a stiff spade or planting bar; and (3) one person dropping plants ahead of setters who each use a trowel or dibble.

On large acreages of comparatively level land, transplanting machines such as those used for tomatoes, cabbages, sweet potatoes, etc., do the setting job quickly and cheaply. An experienced crew can set about 30,000 plants in a 10-hour day, or about 3 to 5 acres. It is ad-




**Set the plants at the correct depth. Plant A is set at the right depth. Plant B is set too deep, and Plant C too shallow. The soil should just cover the tops of the roots.** **(Fig. 9)**

visable to have one man follow the transplanter to reset plants which are not at the right depth or not firmly planted. When set by machine, the plants should be relatively uniform in size and arranged in one direction in the holders. The roots should be straight and trimmed.

Two persons working together with a spade or planting bar can set about 5,000 plants in a 10-hour day. One person handles the spade, jabbing it into the soil about 6 inches and pushing it forward to open a hole. The second person carries the plants and inserts them as the holes are made, keeping the crowns at the proper level and the roots slightly fanned out. After the roots are inserted, the first person withdraws the spade and presses the soil firmly about the roots with his foot or inserts the spade again about 3 inches from the plant and pries the soil firmly against the plant. If the soil is so loose and dry that it falls back into the opening before the plant can be placed, the spade may be inserted at a slight angle from the vertical, lifted up, and the plant placed under the spade before it is withdrawn.

Stiff trowels or dibbles may also be used in planting, the procedure being similar to the one just described except that one person both digs and sets, working behind another person who carries and drops the plants. For maximum efficiency, one person should drop plants for two planters.

Watering the plants when setting them may not be necessary if the soil is moist and the plants are in good condition. If the soil is hot and dry, irrigation should immediately follow planting. A transplanting machine has a definite advantage in that it can water the plants as they are set if the soil is dry. On sandy soils, water alone should be used at setting, but on heavier soils, starter solutions are helpful. Mixtures high in phosphorus, such as 10-52-17, 6-25-15, 8-24-8, or 15-30-14, should be used. The solution should be made up and applied as directed by the manufacturer.

## Training Systems

The matted-row system of culture is practically the only system used by Illinois growers in commercial plantings. The plants are set 18 to 24 inches apart in rows 3½ to 4 feet apart, and the runners are allowed to root at will until the desired width of row is obtained. The width of the matted row varies from 10 to 30 inches, although the intermediate widths (18 to 24 inches) are better. Narrow rows are easier to weed and harvest, produce larger berries, and, since they leave more space between rows, permit better circulation of air between the plants, which reduces the incidence of foliar diseases and fruit rots. Once the rows have reached the desired width, cut off any other runners that develop. A rolling disk attached to the cultivating tool is useful for this purpose.

In the spaced-plant system, the runner plants are arranged by hand until the desired spacing is obtained. Runners formed later are removed as they appear. The final rows are 2 to 2½ feet wide with plants 6 to 12 inches apart in the rows.

In the hill system, all runners are removed so that only the original plant is allowed to grow. This system is used somewhat with everbearing varieties and in small home plantings. Plants are set one foot apart in multiple rows one foot apart. The rows are planted in groups of 2, 3, or 4 with about a 2-foot aisle between groups.

Experiments have shown that both the hill- and the spaced-row systems will outyield the matted row. However, the matted-row system is adapted to machine farming, and the cost of growing an acre is much

lower, thus making the increased yields from the spaced-row and hill systems of questionable value when the grower considers the cost difference against the increase in returns. Furthermore, under conditions of severe drouth or severe winters, a sufficient number of plants in the matted-row system usually survive to give a good stand; whereas the other systems may fail completely.

## CULTURE DURING FIRST SUMMER

### Removing Flowers

During the first summer after setting, flower stems should be removed as they appear because allowing the fruit to form will seriously reduce the number and size of the daughter plants which bear fruit the following season. The number of trips through the patch to remove most of the fruiting stalks will depend much upon the variety. Those varieties that produce only one cluster per plant will obviously require fewer trips than those that produce several blossom clusters per plant. Usually two or three trips over the patch will be sufficient.

### Cultivation

The strawberry has a low habit of growth and is thus not as able as other fruits to compete successfully with weeds for nutrients, moisture, and light. Cultivation should begin as soon as possible after the plants are set. This controls weeds and keeps the soil from getting crusted, thus encouraging the runners to take root. Cultivation should be as frequent as necessary to hold down the weeds but no deeper than 1 or 2 inches near the plants since new roots grow near the top of the crown and are easily cut off. Some growers successfully use a rotary hoe for the first cultivations, before runners are formed. Hoeing will also be necessary to destroy weeds which cannot be reached with a cultivator. Cultivation and hoeing should continue as needed throughout the summer and fall until the first hard frost occurs. Since mulches will protect the late fall weeds as well as the strawberry plants, the planting should be relatively free of weeds before the mulch is applied.

Although quite expensive, many types of cultivating machinery are now available for strawberries which will soon pay for themselves on large acreages. The equipment is designed to reduce the need for hand labor and can also be used for other row crops. Information on self-propelled or sulky-type power hoes, whirlweeders, and rotary-type tillers may be obtained from local implement dealers.

## Geese for Weed Control[1]

The use of geese to do the weeding in several crops is not a new idea — cotton farmers have been using them for many years. The geese can kill many weeds in a strawberry planting without damage to the plants. They may be used in a first-year planting until about mid-September, in the spring of the fruiting season up to about 3 weeks before harvest, and after renovation until about mid-September.

The best number of geese to use is 4 or 5 an acre during an average season and 6 to 8 during a wet one. Any breed of geese will be good for weeding, but the heavier geese seem best. Whatever the breed, goslings are the most efficient, beginning when 6 weeks old. They work best when put in a flock with a few old geese.

A fence definitely is needed to keep the geese in the berry patch. If foxes or dogs are a problem, the fence should be of poultry mesh, 4 feet high. Otherwise a 26-inch hog wire fence is adequate. For either type, firm wooden or steel posts should be spaced no more than 15 feet apart. If shade trees aren't available near the patch, a shelter should be provided to protect the geese from the hot sun. The shelter should be located about 40 feet from the patch, if possible, or the geese will trample the plants around it (Fig. 10).

Their weed diet should be supplemented, but not enough to satisfy their appetites or they won't eat the weeds. About a handful of corn per grown goose per day is sufficient, scattered at one end of the patch. Put a 50-gallon container with a drop spigot to drip water continuously into a shallow basin at the other end of the rows. The geese will eat some of the corn, then waddle along the rows to the water, eating weeds as they go. Don't give high-protein feeds to geese. Use a standard feeding ration for goslings for the first 10 weeks, as they rarely eat whole corn. One more point in regard to feeding habits: the geese may not normally eat certain weeds in the patch. If this is the case, it may be wise to pen a few geese and feed them only those weeds for a time. There are some weeds that geese won't eat for any reason, but it is possible to train them to eat certain other weeds in this way and then return them to the patch.

Clipping a few wing feathers will prevent flight. However, never clip the end feathers on the wings since they are needed to hold the wings on the back.

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[1] Additional information may be obtained by writing for Farmers' Bulletin 767, "Goose Raising," available from the Office of Information, U. S. Department of Agriculture, Washington 25, D. C.

**Troublesome weeds may be controlled effectively by properly managed geese. Shelter should be provided outside the field, and food and water at the edges of the patch to avoid excessive damage to the strawberry plants as is evident here. (Fig. 10)**

Don't use herbicides if geese are being used for weed control. Most insecticides used in strawberry plantings for insect control will not kill the geese, but little is known about what amounts of insecticide residue can be tolerated by them. It may be desirable to remove the geese from the field while insecticides are being applied.

## Chemical Weed Control

The use of chemicals in addition to tillage to control weeds in strawberries has significant possibilities. Although many herbicides are being tested for use on strawberries, more conclusive research is needed before safe general recommendations can be made. Only one chemical, sesone (Crag Herbicide #1), may be safely recommended at the present time. It is effective only against germinating weed seeds and young seedlings. It won't control weeds after they have become ¼ to ½ inch high or weeds that have underground stems such as bindweed or quackgrass.

Use sesone at the rate of 4 pounds an acre on heavy silt or clay soils, 3 pounds an acre on medium loam soils, and 2 pounds an acre on light sandy soils. For small areas use 1 level tablespoon in 1 gallon or more of water for each 200 square feet. Apply the material right

after the ground has been cultivated. Do not apply during the first two weeks after planting. In an established planting, an application at mulch-removal time helps to control the spring weeds and applications after renovation may be made as in new plantings. Ordinarily, strawberry plants will tolerate 5 to 7 well-timed applications a season at intervals of about 4 weeks.

Since the herbicide material does not become active until it is converted to an active form in the soil, it is safe to use near plantings of other crops. The soil should be moist, however, for this change to take place; so irrigation may be necessary during periods of drouth. Since the chemical will be washed away by heavy rains, a new application will be required in such instances.

Sesone is best applied as a uniform spray in any amount of water from 30 gallons up, depending upon the equipment available. Use a low nozzle pressure of about 20 to 60 pounds a square inch. It is more economical to spray only the rows since weeds between the rows may easily be controlled by cultivation.

It is very important to calibrate sprayers carefully to make sure that the right amount of chemical is being applied. A test run should be made over a measured area on the same type of terrain that is to be sprayed. A satisfactory method of calibrating a sprayer is as follows:

**1.** Fill the spray tank with water. If oil or oil emulsions are to be used, the calibration should be made with the complete mixture.

**2.** Spray a measured area at the speed that will be used during the actual application of the herbicide to the strawberry planting.

**3.** Carefully measure the amount of water or complete mixture needed to refill the tank.

**4.** The amount of water or complete mixture used divided by the portion of an acre covered will give the gallons per acre being applied. For example, if 10 gallons of water were applied to ¼ acre, the rate would be 40 gallons an acre.

**5.** Mix the amount of herbicide desired for an acre with this much water.

Tractor speed, pressure, nozzle size, and number of nozzles must remain the same or the amount of liquid applied to an acre will be changed and recalibration will be necessary. It is important to remember also that if band applications are used, adjustment must be made for the area actually sprayed.

Several other chemicals show promise for use as weed killers in strawberry patches. For a more complete discussion of these materials and suggestions on their use, write to the Department of Horticulture, University of Illinois, Urbana, Illinois.

## Plant Thinning

A serious defect in the matted-row system of growing strawberries, as used by practically all Illinois commercial growers, is a too-thick stand of plants at the end of a good growing season. This happens the first year as well as during the bearing seasons. Overcrowded plants produce lower yields of smaller berries and provide a good environment for foliar diseases and fruit rots. Although hand spacing of runners in large acreages is generally impractical, some mechanical thinning can be done in the fall. Dump rakes, side-delivery rakes, or spike-toothed harrows may be used to pull up many late-formed runners, leaving the deeply rooted early runners. The object is to pull these excess runners into the area between the matted rows and then cut them off with rolling disks in front of the cultivator shovels, leaving fewer plants in the matted row and still maintaining the desired row width. The plants that are removed would ordinarily bear only a light crop if any and would be competition for the more important early-rooted plants.

## IRRIGATION

The strawberry plant requires large quantities of water because so much of the fruit consists of water and because it is shallow-rooted. During most years, irrigation could help many Illinois growers and could save the crop in years that drouth occurs during the period of fruit development and maturation. Other critical periods, when irrigation could insure a good crop for the following year, are: immediately following plant setting, during the period of fruit-bud development, and following renovation (Fig. 11). Supplemental irrigation tests at the Agricultural Experiment Station at Urbana have shown that yields may be increased by as much as 3,000 quarts an acre with the use of sprinkler irrigation during a dry season.

The most common types of irrigation systems for strawberries are the sprinkler and surface systems. The surface or furrow system can only be used where the soil, or particularly the subsoil, is heavy and where the slopes are uniform and gentle. A sprinkler system has considerable advantage in that it may be used on any type of soil, on level


**Vermilion strawberry plants in September, following harvest and renovation. (A) plots that had received supplemental moisture, (B) plots that had received no supplemental moisture during a relatively dry season.** ***(Courtesy R. K. Simons, Department of Horticulture, University of Illinois)*** **(Fig. 11)**

or rolling land, and may also be used as a safeguard for protection of blossoms from frost damage in the spring (see "Preventing Spring Frost Injury," page 32).

The following points should be kept in mind when irrigating strawberries:

**1.** Strawberries need about 1 inch of water a week during the grow-

ing season. If rainfall doesn't supply this amount, make up the difference with irrigation.

**2.** Apply water before the plants show symptoms of water deficiency. The time to irrigate may be determined by installing tensiometers or moisture blocks, or by learning to estimate the percentage of moisture in the soil by "feel."

**3.** Sandy soils require more frequent applications of water, and in smaller amounts, than heavier soils because they hold less available water and excessive irrigation will leach out nutrients beyond the depth of the roots.

**4.** Apply enough water at any one time to penetrate to a depth of 6 to 10 inches. The bulk of strawberry roots is found in the top 6 to 10 inches of soil.

**5.** During the harvest season especially, avoid overwatering or the fruit may be too soft for shipment to distant markets. Maintain an abundant supply of water during the blossoming period and up to the time of the development of pink color in the fruits. After this time, irrigate moderately if a drouth occurs.

## FERTILIZERS

Available information on fertilizing strawberries leaves much to be desired, but studies indicate that strawberry plants have nutrient needs similar to those of many other farm crops and that liberal fertilization will prove to be profitable with most plantings in Illinois. The applications of commercial fertilizers to meet these needs should be governed by soil tests, which will give accurate information about the fertility of soils if the soil samples accurately represent the soil in the field. Instructions for getting the soil-testing job done effectively may be obtained from your county farm adviser or from the Soil Testing Laboratory, Agronomy Department, University of Illinois, Urbana.

The usual times to apply fertilizers to strawberries are before planting, during the growing season for newly set beds, and after harvest when the fruiting beds are to be kept another year.

### Before Planting

Barn manure is an excellent fertilizer for strawberries and should be used whenever available, providing that it is not full of weed seeds. If it is full of weed seeds, the manure may be somewhat more safely applied to the cultivated crop preceding the strawberries. Apply 10 to 30 tons of fresh manure an acre the fall before spring planting.

The same quantity may be broadcast and disked in before planting in the spring if it is well rotted and relatively seed free. Since manure is low in phosphorus, it should be supplemented with about 50 pounds of 20-percent superphosphate per ton or an equivalent amount of phosphorus from some other source.

If manure is not available in sufficient quantities, commercial fertilizers should be applied in the spring before planting. The amount to apply should be based on the results of soil tests for phosphorus and potassium. Until more is known about the fertility requirements of strawberries, the quantities of these two nutrient elements as given in Table 3 may be used as a guide. The requirements in pounds an acre are identical with those recommended for legume and grain crops on Illinois soils and should be regarded as minimum requirements for strawberries since the latter are more intensively cultivated and bring much higher returns an acre.

**Table 3. — A Guide for Phosphorus and Potassium Applications Where Soil Tests Are Made by the Illinois Soil-Testing System[a]**

| Soil test rating, P or K | Requirements in pounds per acre[b] Phosphorus | | Potassium | |
|---|---|---|---|---|
| | $P_2O_5$ | 20% superphosphate | $K_2O$ | 60% muriate of potash |
| *(1)* | *(2)* | *(3)* | *(4)* | *(5)* |
| Very low | 160 | 800 | 300 | 500 |
| Low | 150 | 760 | 240 | 400 |
| Slight | 130 | 640 | 180 | 300 |
| Medium | 60 | 300 | 120 | 200 |
| Medium+ | ... | ... | 90 | 150 |
| High | 0 | 0 | 75 | 125 |
| Very high | 0 | 0 | 0 | 0 |

[a] Adapted from Ill. Agr. Ext. Ser. Cir. 724, "Soil Treatment Recommendations Based on Soil Tests." 1954.

[b] Columns 2 and 4 may be used in calculating the amounts of mixed fertilizers or other sources required to supply the needed phosphorus or potassium. Columns 3 and 5 may be used directly. For example, if the soil test results show very low phosphorus and high potassium, the requirements would be met by applying 800 pounds of 20% superphosphate and 125 pounds of 60% muriate of potash.

It is well known that strawberries need plenty of nitrogen early the first year for maximum growth. Regardless of the potassium and phosphorus requirements, 50 to 60 pounds of actual nitrogen should be applied before planting.

If no soil tests are made, apply 400 to 600 pounds an acre of 10-20-20 or equivalent before planting. Use the lower rate for soils that are relatively high in fertility and the higher rate for those less fertile.

The most common method of application is that of broadcasting the fertilizer over the entire area and working it in about 10 days before planting. Broadcast application is probably the safest but not the most economical way to apply fertilizer. It promotes weed growth and is not as desirable as placement in bands. If band placement is used, half the fertilizer to be used should be applied in a single band down the middle of the beds about one week before planting. The fertilizer should be placed quite deep so that it will be just below the roots when the plants are set. Before the runners start spreading, apply the other half in narrow bands, 3 or 4 inches deep, on each side of the original band. No more than 300 to 400 pounds an acre of a high-analysis fertilizer should be put in bands close to the plants, or burning may result. When the total amount of fertilizer required exceeds about 600 pounds, the excess should be broadcast before the plants are set.

## During First Growing Season

An application of nitrogen alone is frequently beneficial when made between August 15 and September 1 each year since it aids in flower-bud formation for next year's crop. Broadcast 30 to 35 pounds of actual nitrogen an acre over the plants. Reduce this amount to allow for partial coverage if only the rows are fertilized. Apply the fertilizer when the plants are dry, and brush it off immediately or serious foliage injury will result, particularly if ammonium nitrate is used. A heavy rope, burlap sacks, or a bundle of fine brush may be dragged over the rows to brush off the fertilizer.

When the above schedule has been followed, no additional fertilizer should be necessary until after harvest. Nitrogen fertilizers applied in the spring during a fruiting year are likely to produce heavy foliage, soft berries, and increased rot, and thus should be avoided. If the plants show a need for nitrogen in the spring of a fruiting year, apply only enough fertilizer to supply a maximum of 10 pounds of actual nitrogen an acre. For a quick response at this time, use a urea spray of 5 pounds in 100 gallons of water and spray 200 gallons an acre.

## After Harvest

After the leaves are mowed and raked off with the excess mulch, but before the rows are narrowed (see "Renovation," page 30), apply about 500 pounds of 10-10-10 or 12-12-12 or equivalent an acre. Follow this application with a fruit-bud application between August 15 and September 1 as for a new planting.

## LIME

Strawberries tolerate quite a wide range in pH. No liming should be needed if the acidity measures between pH 5.0 and 7.5. Lime should not be applied directly to strawberry plants. It has been shown that an excess of lime dwarfs the plants and reduces the size of the berries. If, however, soil tests show a pH value of less than 5.0, lime should be applied at least a year before strawberries are planted. Where the pH is 4.5 to 5.0, use from 1,000 pounds an acre of limestone on light soils to 2,000 pounds on heavy soils. Where the pH is less than 4.5, use from 1,500 pounds on light soils to 3,000 pounds on heavy soils.

## MULCHING

The principal uses of a mulch on strawberries are to protect the plants during the winter from extreme cold and from heaving, to conserve moisture, to protect flowers from frost, and to provide cleaner berries and better harvest conditions. The value of a mulch in keeping the fruit clean and providing better conditions for the pickers warrants its use throughout Illinois, regardless of other advantages.


**(A) Wheat-straw mulch properly applied for winter protection. (B) Unmulched plants injured by severe cold and heaving. (Fig. 12)**

**Materials and application.** Wheat straw is the best material to use (Fig. 12). Pine needles, wild hay, leaves, rye straw, and oat straw may be used, but none of these materials is as satisfactory as wheat straw. Apply the mulch after the plants become dormant but before the temperature drops below 20° F. in the fall. This occurs between mid-November and mid-December, depending on what part of the state one lives in and also depending on the year. Mulching machines or manure spreaders may be used on large commercial acreages to spread a uniform layer over the plants. A mulch about 2 inches thick when settled (both over and between the rows) requires about 3 tons of straw to an acre and is sufficient for northern Illinois. In the southern part of the state the winters are milder; so about 1½ to 2 tons an acre is satisfactory.

Weed sprouting may be minimized by using straw one year old. If new baled straw is used, distribute the bales over the patch in early fall and break them open for a thorough rain-soaking. Weed seeds in the straw then will germinate before it is spread. Stacked straw should be spread 2 to 3 feet deep for soaking and weed sprouting before it is spread over the patch.

Growing a mulch crop between the strawberry rows in early fall is not recommended. The two crops compete with each other for nutrients and moisture to the detriment of the strawberries.

**Black plastic film used with the single-row hill system.** **(Fig. 13)**

**Removal in spring.** Leave the mulch on the plants in the spring until the new strawberry leaves under it are slightly yellow, then remove part of it from the rows to the middles. Leave a thin layer for the plants to grow up through. The excess mulch in the middles may be put back on if frost threatens.

**Plastic mulch.** Black plastic film is being used to some extent in strawberry growing, but it is still considered in the experimental stage (Fig. 13). It is effective in keeping down most weeds in the row and in conserving moisture. In some situations it has helped to keep berries clean and has reduced rot. Only the hill system of culture is adapted to its use because the plastic prevents runners from taking root. Cost of the plastic is estimated at $150 to $175 an acre.

## RENOVATION

What happens to a strawberry planting after harvest has much to do with the following season's crop. The sooner after harvest that the patch is cleaned up, fertilized, and, if possible, irrigated, the better will be the chances of getting a good crop the following year.

Usually a strawberry planting is renovated once or twice and then plowed under, but if a grower has a good site and uses the best cultural practices, plantings may be maintained for longer periods. One planting of the Blakemore variety in southwestern Illinois has been maintained in excellent condition through nine harvest seasons. This is an unusual case and is possible only when the plants are vigorous and when weeds, diseases, and insects are not a problem.

If the soil is fertile and relatively free of weeds and if the plants are vigorous and healthy, it is generally worthwhile to renew the patch. The object of renovation is to destroy most of the plants, saving only enough to re-establish a full stand of new runners for the following season. The following procedure is suggested:

**1.** Immediately after the last picking, mow the old foliage as close to the ground as possible without injuring the crowns. Rake the leaves and remaining mulch from the patch and burn them if there is a disease or insect problem. If the mulch is not very heavy and the insect and disease problem is not serious, the leaves and mulch may be worked into the soil without raking. Burning over the patch is sometimes practiced, but it is quite risky. The old foliage, weeds, and mulch must be dry, the ground and crowns of the plants must have a high moisture content, and there must be a good wind blowing to carry the fire rapidly across the patch.

If the soil is very dry and irrigation is available, water the soil after performing step 1. If you can't irrigate and the weather is dry, it may be wise to delay the following steps for as much as 10 days.

**2.** Broadcast 500 pounds an acre of a 10-10-10 or 12-12-12 fertilizer or equivalent over the tops of the plants. If soil tests are made and they indicate high phosphorus and potash, use only nitrogen at 50 to 60 pounds of actual nitrogen an acre.

**3.** Narrow the beds to 8 to 12 inches. The method used depends on soil type, weather, and equipment available to the grower. Some growers narrow the rows from each side with a cultivator or bar off with a plow, leaving the desired width. Some growers narrow the rows by removing one half of the bed one year and the other half the next. Others "bust out" the middles of the rows each year. A good machine for narrowing the rows is a rotary-type tiller (Fig. 14), which can be adjusted to obtain the desired width of row. U. S. Department of Agriculture findings demonstrate that the original plants can produce good crops for several seasons, so a narrow strip of plants down the center of the row is satisfactory.

**Renovating a strawberry patch with a rotary-type tiller, which may be adjusted for the desired row width.** (Fig. 14)

**4.** Clean out the narrowed rows and thin out the remaining plants, preferably by hoeing. Some growers operate a section harrow diagonally across the beds, with the spikes nearly perpendicular, to thin out the plants and cover small weeds. This may be dangerous, especially on hardpan soils where severe use of the harrow may injure the remaining plants and prevent the formation of a full bed for the next season.

**5.** If soil moisture is deficient and irrigation is available, irrigate again after the patch has been worked. Strawberries need abundant water at this time to recover from fruiting and to make new plants for the next crop (see "Irrigation," page 23).

**6.** After renovation, cultivate, control weeds, and if possible, irrigate, as during the maintenance of a first year planting.

If, for any reason, renewing the patch is delayed for much more than 10 days after the last picking, it may be better to just narrow the rows slightly and cultivate thoroughly between the rows. Mowing of fresh, green, active leaves will set the plants back, and severe narrowing of the rows too long after harvest may leave insufficient time for the establishment of new runner plants for the next crop.

## PREVENTING SPRING FROST INJURY

Since the strawberry plant lies close to the ground, where the temperature is considerably lower than in the branches of trees, its blossoms are more likely to be killed by frost than are those of fruit trees. On the other hand, since strawberries blossom over a period of three or more weeks, it is unlikely that all of the blossoms will be killed. During most springs in Illinois, late spring frosts will kill some of the blooms in a strawberry planting and these are usually the first flowers that open, the ones which would otherwise develop into the largest berries. The loss of these large, early berries means a real financial loss to the grower.

No strawberry variety is "frost proof," but some are more vulnerable than others. The varieties with long fruit stalks, which elevate the blossoms well above the foliage, are especially susceptible and should be avoided where spring frosts are a danger. Blossoms are most easily injured when they first expand and during fertilization. A light frost merely touches the point of the cone of pistils, causing the berries to "button." Buttoning, however, is not due to frost altogether; dry weather, a low nutrient level, or insect injury may also cause buttons. The injury from frost is usually confined to the pistils, which

**Strawberry blossoms injured by frost. The dark centers are dead pistils. This injury could have been prevented by mulch, sprinkler irrigation, or moving air. (Fig. 15)**

turn black (Fig. 15). The stamens and petals are not injured, and the blossom looks normal unless examined closely.

One practical method of reducing the hazard of frost injury is to select an elevated site for the strawberry planting (see "Sites," page 5). Other methods commonly used are (a) covering the plants with mulch and (b) spray irrigation.

A light covering of mulch will protect against most frosts, but only enough straw should be used to barely cover the plants. If the heavy winter mulch has been left in the middles, it is ready to be used for covering the plants when frost threatens. Since strawberry flowers may be pollinated over a period of several days during cool weather, the mulch may be left on the plants for 2 or 3 days if frosts are expected on successive nights. Sometimes muslin, cheesecloth, or kraft paper is used on smaller plantings.

Portable sprinkler irrigation is especially effective in preventing injury, as is attested by its popularity in Michigan where it is used on over half of the state's strawberry acreage. Frost control with tempera-

tures as low as 20° F., combined with the benefits derived during dry periods in supplying the necessary moisture to mature a satisfactory crop, make sprinkler irrigation systems worthy of consideration by progressive strawberry growers.

A "fogging" effect is obtained by using special frost nozzles with small openings which provide protection against frost injury but do not saturate the soil except during prolonged frost periods. Each grower who installs a spray-type irrigation system will have individual problems concerning what sprinkler types, sizes, pipes, spacing, and pressure to use. Such information may best be obtained from growers with experience or from reliable dealers in irrigation equipment.

In order to be effective during freezing weather, sprinkler systems should be turned on when the temperature at the ground level gets down to 34° F. and should be left on until the freeze is over and the temperature rises above 32° F. again and all the ice melts. Even though the plants may be covered with ice, as long as there is free water on the outside of the ice, the heat that is released as the water cools and freezes will keep the temperature of the plant tissues around 32° F., and there will ordinarily be no injury.

Other methods of frost prevention include large, power-driven fans, smudging, and heating. Wind-making machines are available that will stir the air over approximately 20 acres. They are worth considering where conditions are favorable. Heating and smudging are usually rather expensive methods and are effective only when atmospheric conditions are just right to produce a "layering" effect.

## HARVESTING AND HANDLING

The strawberry harvesting season in Illinois usually extends from early May in the southern counties to early July in the northern part of the state. The length of the picking season in any given area varies with the varieties grown and the season. Some varieties pick off in less than 2 weeks while others have picking seasons of 3 or 4 weeks. In a hot, dry year, the picking season will be short, but when the weather is cool with abundant rainfall, picking will continue over a longer period. On the average, the first mature berries appear about 30 days after the first blossoms have fully opened.

### When and How to Pick

Berries for local sales and for processing should be harvested when they are fully mature and at the peak of their flavor. If they are to be

shipped, they should be harvested slightly ahead of full maturity in order to be firm enough to stand the handling and not be overripe when they are purchased by the consumer. Generally, berries about three-quarters red are suitable for 24-hour shipment and those with full red color, but firm, for 12-hour shipment. Berries that are harvested when three-quarters red will develop full red color in a day or two at 70° F. and do not differ appreciably in flavor and size from fully red berries. Berries that are harvested when one-half red or less will also develop full red color but will be poorer in flavor and texture and smaller than berries three-quarters red. Thus growers who harvest berries that do not meet the U.S. No. 1 grade for color are sacrificing both quality and size.

The berries should be picked every other day in warm weather and at least every three or four days in cool weather. Picking on rainy days should be avoided because such fruit will not ship well. The best time to pick is early in the day while the berries are cool. If picking continues into the heat of the day and the fruit is to be kept overnight in the packing shed, it is advisable to let the boxes stand uncovered in the shade until they cool. Boxes of warm berries placed in crates as they come from the patch won't cool sufficiently, and frequently the berries in the lower tier of boxes in the crate will arrive on the market in poor condition. Regardless of the time they are picked, strawberries should not be left in the sun after picking, but should be put in a cool place immediately.

When picking berries for the fresh market, leave the caps and a portion of the stem on. This means that the berries should be pinched off by breaking the stem close to the cap, not pulled off. For processing, pick the fruit with the caps off by holding the stem and cap with the fingertips of one hand and pulling the berry off with a slight twist with the fingers of the other hand.

## Pickers

For a successful harvest, it is important to have enough pickers, to teach them proper picking, and to supervise them carefully. Having someone to help each picker get started so that he knows what is expected of him can pay dividends by the end of the harvest. Inexperienced pickers should be told how to pick with the most speed and least damage to the fruit and plants, the degree of fruit maturity desired, how to fill the boxes, and what to do with small or rotten berries. A competent foreman must be in charge of the picking crew to see that the fruit is being handled correctly and that the rows are

**The patch foreman can improve the over-all quality of the fruit being picked by an occasional check of a box of berries from each picker's carrier. (Fig. 16)**

being picked clean. An occasional check by the foreman on a box of berries from each picker's carrier can contribute much to the over-all quality of the fruit being picked (Fig. 16).

Large growers need to devote some time to recruiting pickers if they are to have enough of them at the proper time. Labor offices, newspaper advertisements, and radio and television announcements may be utilized for this purpose. Some growers keep records of pickers from previous years and send out notices to them in advance of harvest each year.

The number of pickers needed depends upon their efficiency, the seasonal conditions, and the crop yield. Usually 8 to 10 pickers an acre are needed in warm weather and 4 to 6 should keep an acre clean in cool weather.

A simple method of keeping records of the pickers must be followed. Some growers issue numbers to the pickers and keep a record in the packing shed. Others issue tags which may be punched to keep a record of the number of quarts picked, while still others may pay the picker in cash for each box of berries brought to the shed. The pickers are usually paid about one-fifth of the sale price of the fruit. It is a good practice to retain ½ or 1 cent a quart until the harvest is over in order to hold the pickers through the entire harvest season.

## Grading

Graded fruit, whether it is for local markets or for shipment to distant markets, sells at a sufficiently higher price than ungraded fruit to return a good premium even after deducting the extra cost of grading. Experienced pickers can satisfactorily grade the berries right in the patch while picking. More commonly, grading is done in packing sheds by carefully pouring the berries from one box to another, discarding the berries that do not meet the grade. Pan grading is a preferred method which involves emptying one box of fruit at a time into a triangular pan, removing all the inferior berries, then pouring the remaining good ones back into the box, always handling the fruit as gently as possible.[1]

In the Illinois Standardization Law, now in force, certain grades have been adopted by the State Department of Agriculture governing the sale or offering for sale of strawberries in "closed packages," and the producer is liable for the fulfilment of this law. A crate of strawberries is a closed package in that all its contents cannot be seen readily or inspected after such a package is prepared for market. The United States grades have been adopted in Illinois and are known as the Illinois-U.S. Standards.

The "U. S. Standards for Strawberries," as given by the U. S. Department of Agriculture, are:

The tolerances for the standards are on a container (cup) basis. However, individual containers in any lot may vary from the specified tolerances as stated below, provided the averages for the entire lot, based on sample inspection, are within the tolerances specified.

For a tolerance of 10 percent or more, individual containers in any lot may have not more than one and one-half times the tolerance specified, except that when the container has 15 specimens or less, individual containers may have not more than double the tolerance specified.

For a tolerance of less than 10 percent, individual containers in any lot may have not more than double the tolerance specified, provided at least one specimen which does not meet the requirements shall be allowed in any one container.

### Grades

**U. S. No. 1** shall consist of strawberries of one variety or similar varietal characteristics with the cap (calyx) attached, which are firm, not overripe or undeveloped, and which are free from mold or decay and from damage caused by dirt, moisture, foreign matter, disease, insects, or mechanical or other means. Each strawberry shall have not less than

[1] A satisfactory pan for grading may be constructed of light sheet metal. The opening at the narrow end of the pan is from 4 to 4½ inches wide, small enough to fit into a berry box. The pan is 10 to 11 inches long and widens toward the top to about 9 inches. The sides are about 1¾ inches high. For a smooth edge, bend back an extra ¼ inch around the three longest sides.

three-fourths of its surface showing a pink or red color. Unless otherwise specified, the minimum size shall be not less than three-fourths of an inch in diameter.

In order to allow for variations other than size, incident to proper grading and handling, not more than a total of 10 percent, by volume, of the strawberries in any container may be below the requirements of this grade, but not more than 5 percent shall be allowed for defects causing serious damage, and not more than two-fifths of this amount, or 2 percent, shall be allowed for strawberries affected by decay.

In addition, not more than 5 percent, by volume, of the strawberries in any container may be below the specified minimum size.

**U. S. No. 2** shall consist of strawberries which are free from decay and from serious damage caused by dirt, disease, insects, mechanical or other means. Each strawberry shall have not less than one-half of its surface showing a pink or red color. *Unless otherwise specified,* the minimum size shall be not less than five-eighths of an inch in diameter.

In order to allow for variations other than size, incident to proper grading and handling, not more than a total of 10 percent, by volume, of the strawberries in any container shall be allowed for defects causing serious damage, but not more than 3 percent shall be allowed for strawberries affected by decay.

In addition, not more than 5 percent, by volume, of the strawberries in any container may be below the specified minimum size.

**U. S. Combination.** Any lot of strawberries may be designated "U. S. Combination" when not less than 80 percent, by volume, of the strawberries in each container meet the requirements of U. S. No. 1 grade and the remainder meet the requirements of U. S. No. 2 grade, except for size. *Unless otherwise specified,* the minimum size shall be not less than three-fourths of an inch in diameter.

In order to allow for variations other than size, incident to proper grading and handling, not more than a total of 10 percent, by volume, of the strawberries in any container shall be allowed for defects causing serious damage, provided that not more than one-fifth of this amount, or 2 percent shall be allowed for strawberries affected by decay. No part of any tolerance shall be allowed to reduce for the lot as a whole, the percentage of U. S. No. 1 strawberries required in the combination, but individual containers may have not less than 65 percent U. S. No. 1 strawberries provided the entire lot averages within the percentage required.

In addition, not more than 5 percent, by volume, of the strawberries in any container may be below the specified minimum size.

**Unclassified** shall consist of strawberries which have not been classified in accordance with the foregoing grades. The term "unclassified" is not a grade within the meaning of these standards but is provided as a designation to show that no definite grade has been applied to the lot.

### Definitions of Terms

As used in these standards:

"Overripe" means dead ripe, becoming soft, a condition unfit for shipment and necessitating immediate consumption.

"Undeveloped" means that the berry has not attained a normal shape and development due to frost injury, lack of pollination, insect injury, or other causes. "Button" berries are the most common type of this condition.

"Damage" means any injury or defect which materially affects the appearance or the edible or shipping quality.

"Serious damage" means any injury or defect which seriously affects the appearance or the edible or shipping quality. Soft, badly deformed, badly bruised, decayed or leaky strawberries, or strawberries which are caked with dirt or which have less than one-half of the surface showing pink or red color shall be considered as seriously damaged.

"Diameter" means the greatest dimension measured at right angles to a straight line running from the stem to the apex.

### Packing

Boxes should be packed so that the berries come slightly above the top and with the corners filled. One-quart veneer boxes are the most widely used. Smaller boxes or those made of plastic or paper have not yet gained general acceptance in the state. Wire-bound or nailed 16-quart wooden crates are used almost exclusively in Illinois. A few growers with special market outlets use 8-quart cardboard crates.

A good way for a grower to establish a reputation with buyers is to have a consistently high-quality pack with his name and the variety grown stamped on each crate.

## EVERBEARING STRAWBERRIES

The so-called "everbearing" strawberries differ from the standard varieties in that they bear fruit during the same season that the plants are set and bear more or less continually throughout the summer and fall until frost. They are not recommended for general commercial planting but are popular with home gardeners and may be grown on a limited scale near cities for local sales. Under Illinois conditions they produce only fairly good fruit at best in comparison with the better standard varieties.

Large commercial plantings of everbearers are not recommended because growing and harvesting costs are greater and the attention to cultural needs is more exacting than for standard varieties. Also, the fruits are likely to be soft and to lack flavor during hot weather. Irrigation usually is needed to produce the summer and fall crops.

One of the best ways to grow everbearing strawberries is in the hill system in a 3- or 4-row bed-type planting. The plants are set 1 foot apart in rows which are also 1 foot apart. A 2-foot alley is left between each 3- or 4-row bed. The planting should be cultivated and

hoed the first 2 or 3 weeks after planting, then the entire bed should be mulched with sawdust or ground corncobs in a layer 1 inch thick (Fig. 17). About 2 cubic yards of mulch are needed to cover a patch 40 x 15 feet or 150 cubic yards to cover an acre. Apply about 30 pounds of actual nitrogen an acre before the sawdust is spread and a similar quantity after the June crop is harvested for as long as the bed is kept.

The blossoms should be picked after spring planting until about mid-July, the first season only. All runners are removed as fast as they form throughout the life of the planting. Some plantings are destroyed after bearing the first summer and fall crop, but oftener the patch is carried over the winter to produce a spring crop and a second summer and fall crop. The planting is seldom maintained longer than two growing seasons.

The choice of everbearing varieties is limited to a smaller number than with the standard types. Gem (indistinguishable from Superfection, Brilliant, and Pennholm Everbearing) and Twentieth Century are recommended varieties. Chief Bemidji, Ogallala, and Ozark Beauty are promising newer varieties which are recommended for trial.

Everbearing strawberries in the 4-row bed-type planting mulched with ground corncobs. (Fig. 17)

# PART II—CONTROLLING COMMON INSECTS AND DISEASES[1]

The control of insects and diseases has become increasingly complex, partly because more is being learned about the pests themselves and about what chemicals are needed for their control.[2] But control is also complicated by other factors. One is the trend toward concentrated production. Pests that usually are readily controlled on small and widely separated plantings become harder to keep down when large acreages are used and the same land is repeatedly planted to strawberries. Another factor is that insects or diseases that have not been common may become so. In case such a pest is one that causes serious damage whenever it does become common, a great deal of harm can be caused very suddenly. In addition to this, during some years the weather in a given locality may entirely cancel out the effect of all the known measures for the control of some pests.

Strawberry growers have placed increasingly great reliance on sprays and dusts and on virus-free nursery stock, but they also regularly employ sanitary and cultural measures. These include using a good site, clean tillage, correct renovation, and suitable, resistant varieties when they are available. If sanitary measures are used alone, infection may become heavy enough within a few years to seriously cut yields. Therefore frequent rotation has always been a standard practice among growers. The more recent controls have not put this practice on the shelf. What they have done is to greatly improve the productivity of the plants while they are bearing and to delay the buildup of the diseases, insects, and viruses that make plowing under necessary.

Chemical controls may help the grower, but he must not overrate their effectiveness. If it rains heavily at a crucial time, for instance, the sprays and dusts may be of little value. Furthermore, chemicals are not always as effective as we would like them to be. Virus diseases are subject to chemical control only insofar as chemicals destroy the insects which carry them. Once such an infection starts, the plant cannot be saved. Some fungi that are directly affected by chemicals are difficult to control because they are hard to reach. For example, some attack the underside of leaves and hence the spray or dust must be

[1] The material on insect control was prepared in cooperation with the Illinois State Natural History Survey.

[2] Growers may keep up to date on chemical controls by writing for the latest *Fruit Leaflet No. 1,* which is published yearly. Write to Department of Plant Pathology, University of Illinois, Urbana, Illinois.

applied there. The control of insects and diseases depends upon all the measures named, including rotation. Obviously it also depends upon judgment and vigilance by the grower.

The common insects are the leaf roller, the tarnished plant bug, and the strawberry weevil. In recent years, mites have also become a serious problem and have required special measures for control. Any of the insects discussed in the following pages can become serious. The most common diseases that attack strawberries are leaf scorch, leaf spot, gray mold, and the red stele root rot.

**General use of sprays and dusts on established plantings.** Many chemicals are used as foliage sprays or dusts for strawberries. They include DDT, TDE, malathion, Trithion, kelthane, thiram, and captan. Growers are responsible for any residue found on the fruit in excess of the tolerance. Table 4 shows the specific restriction that applies to each chemical. Some chemicals may be applied only in soil treatment before planting. Others can be used during early bloom, that is before the fruit has formed. Some may be used up to within a few days of harvest, and a few can be used without restriction. Some chemicals may also be used as post-harvest dips.

Before a chemical can be labelled for use, the manufacturer must submit to the U.S. Department of Agriculture documented evidence which substantiates the use claims made. If such claims for use are consistent with limitations and restrictions which have been imposed upon this chemical by the Food and Drug Administration, then a registered label is approved and the material can be marketed. Thus a label should be considered the latest information concerning the use of an agricultural chemical. *Therefore, read the label carefully.*

**Table 4. — Chemicals Approved for Use on Strawberries in Illinois as of January, 1960, Their Residue Tolerance in Parts per Million, and Limitations and Restriction on Use[a]**

| Chemicals | Residue tolerance | Restrictions and limitations |
|---|---|---|
| | *(p.p.m.)* | |
| Aldrin | .1 | Preplanting soil treatment only |
| Aramite | 0 | Do not apply after edible parts start to form |
| BHC | 5.0 | Do not apply after edible parts start to form |
| Bordeaux mixture | exempt | No time limitation |
| Calcium arsenate | 3.5 | Do not apply after edible parts start to form |
| Captan | 100.0 | No time limitation |
| Chlordane | .3 | Do not apply after edible parts start to form |

[a] Compiled from information obtained from the Pesticides Regulation Branch of the Agricultural Research Service, U. S. Department of Agriculture.

Table 4. — (continued)

| Chemicals | Residue tolerance | Restrictions and limitations |
|---|---|---|
| | *(p.p.m.)* | |
| Chlorinated trisodium phosphate | NR[a] | Add in wash water, rinse before canning |
| Chloropicrin | NR | 2 weeks before planting; aerate before planting |
| CIPC | NR | Dormant treatment only |
| Copper sulfate (basic) | exempt | Prebloom and post-harvest |
| Cryolite | 7.0 | Do not apply after edible parts start to form |
| 2,4-DDP[b] | NR | Preplanting soil treatment only; allow at least 14 days between treatment and planting; do not treat more than once a year |
| 2,4-D | NR | Dormant, before blossoming, and after harvest before runners start |
| DDT | 7.0 | As a spray or dust use before fruit forms and after harvest; on soil use before planting |
| Dehydroacetic acid | 65.0 | As an after-harvest dip |
| Demeton | .75 | Do not use within 21 days of harvest |
| Diazinon | .75 | Do not use within 5 days of harvest |
| Dichlone | 15.0 | Do not apply within 3 days of harvest |
| Dieldrin | .1 | Preplanting treatment on soil |
| Dibrom | NR | Do not use within 4 days of harvest |
| DNAP | NR | Dormant treatment to middle and shoulder of beds |
| DNAP-DNBP (mixture) | NR | Dormant treatment only |
| DNBP | NR | Dormant treatment only |
| Ethylene dibromide | 5.0 | Preplanting soil treatment; 3 weeks aeration |
| Ferbam | 7.0 | Not after full bloom |
| Karathane | NR | Do not apply within 21 days of harvest |
| Kelthane | 5.0 | Do not use within 2 days of harvest |
| Lead arsenate | 7.0 | Do not apply after edible parts start to form |
| Lindane | 10.0 | Do not apply after fruit starts to form |
| Malathion | 8.0 | Do not use within 3 days of harvest |
| Methoxychlor | 14.0 | Do not use within 14 days of harvest |
| Methyl bromide | 30.0 | Treat plants under tarpaulin from 1¾ to 2¾ hours, depending on temperature |
| Nicotine sulfate | 2.0 | Do not use within 14 days of harvest |
| Ovex | NR | Post-harvest treatment only |
| Parathion | 1.0 | Do not use within 14 days of harvest |
| Paris green bran bait | 3.5 | Sprinkle ground, avoid contamination of plant parts |
| Phenylmercury acetate | NR | Apply before growth starts in the spring and after harvest as needed |
| Potassium cyanate | NR | Dormant treatment only |
| Rotenone | exempt | No time limitations |
| Sesone | 2.0 | Do not use within 7 days of picking |
| Sulfur | exempt | No time limitations |
| TDE | 7.0 | Spray—no application after fruit begins to form; dusts—do not apply within 5 days of harvest |
| Thiram | 7.0 | Do not apply within 3 days of harvest unless residue is removed by washing |
| Toxaphene | 7.0 | Do not apply after fruit begins to form |
| Trithion | .8 | Do not apply within 3 days of harvest |
| Zineb | 7.0 | Do not apply within 7 days of harvest |
| Ziram | 7.0 | If applied within 7 days of harvest, remove residue by washing fruit |

[a] No residue tolerance established; therefore none is allowed.
[b] *O*-2,4-dichlorophenyl, *O,O*-diethylphosphorothioate.

In general, spraying with a combination of malathion, DDT, and captan in early bloom, followed by applications of either captan or thiram at 7 to 10 day intervals, will help a great deal, providing the other controls discussed above have been followed (see Table 5). The early bloom spray controls the strawberry weevil (clipper), the catfacing insects, the gray mold blossom blight, and the leaf diseases. It may be followed up with specific measures, when such are available, if a particular insect or mite infestation or disease breaks out. Kelthane and Trithion, which are acaracides, may be used up to within 2 and 3 days, respectively, of harvest, and captan, a fungicide, may be used practically without restriction. If an insect infestation should develop, then apply malathion again. It is advisable to make close observations to try to spot any insect infestation or disease which may become established.

When making up the combination spray for use during early

**Table 5. — Insect and Disease Control Spray Schedule**

| Time to apply | Materials | Amounts of mixture to use | | |
|---|---|---|---|---|
| | | 1 gal. water[a] | 100 gal. water[b] | Per acre |
| 1. Immediately after removing mulch | Organic mercury | Follow directions on package label. | | |
| 2. First appearance of blossoms | 50% captan | 2 tbs. | 2 lb. | 5-6 lb. |
| | 50% DDT | 2 tbs. | 2 lb. | 5-6 lb. |
| | 25% malathion | 4 tbs. | 4 lb. | 10-12 lb. |
| 3. 7-10 days after 2nd spray | 50% captan | 2 tbs. | 2 lb. | 5-6 lb. |
| | —or— | | | |
| | 50% thiram | 2 tbs. | 2 lb. | 5-6 lb. |
| Repeat Spray No. 3 at 7- to 10-day intervals until harvest if infection occurs again. Malathion may be added if an insecticide is necessary, and Kelthane may be used for mite control. Trithion also may be used for insect and mite control. SEE LIMITATIONS (Table 4) ON USE OF CHEMICALS. | | | | |
| 4. 10-14 days after renovation | 50% captan | 2 tbs. | 2 lb. | 5-6 lb. |
| | —or— | | | |
| | 50% thiram | 2 tbs. | 2 lb. | 5-6 lb. |
| | plus | | | |
| | 25% malathion | 4 tbs. | 4 lb. | 10-12 lb. |
| If infestation or infection occurs, apply the chemicals for insect and disease control up to winter mulch. | | | | |

[a] Apply 1 gallon of spray, at the concentration indicated, to a row of strawberries 2 feet wide by 70 feet long.

[b] It is preferable to use the concentrations recommended in this column and to apply 250 to 300 gallons of water per acre. If this much water cannot be applied in one trip, then adjust the concentration so that the total amounts of the active ingredients are actually used. In any case, use at least 100 gallons of water per acre.

bloom, it is important to use at least 2¼ to 3 pounds of the active ingredient of each formulation per acre with each application. For example, a dust containing 7.5 percent each of captan, DDT, and malathion should be applied at the rate of approximately 30 to 40 pounds an acre. Sprays may be made up from wettable powders. Add 2 pounds each of 50-percent captan, 50-percent DDT, and 50-percent malathion to 100 gallons of water and apply so that 250 to 300 gallons of spray are used an acre for each application. Should the sprayer discharge be such that only 100 gallons an acre can be applied with a once-over treatment, then 5 to 6 pounds of each 50-percent wettable powder should be mixed with 100 gallons of water. To regulate the amount of chemical used, the volume of spray that the equipment delivers to the acre must be known. This may be determined by first spraying a measured area (see page 22).

Several satisfactory types of sprayers and dusters can be bought. The 3-gallon air-pressure sprayer, which the operator may carry on his shoulder or at his side, is well suited to the small patch. Small hand dusters are quite efficient. On larger plantings, use a power sprayer or duster made especially for use in small fruit and vegetable growing. *Clean equipment carefully after use.*

## INSECTS

Since insect control partly depends on the grower's being able to identify the insects which cause trouble, the authors suggest the following reference work: *Destructive and Useful Insects,* third edition, by C. L. Metcalf, W. P. Flint, and R. L. Metcalf (McGraw-Hill Publishing Co., New York, 1951).

**White grub.** The white grub is the immature, or larval, stage of the June bug or May beetle. This insect lives and feeds in the ground for one to three years in the larval state. If the patch has been in sod just before planting, this grub may be in the soil and will attack the roots and crowns of the plants. For information on preparing the soil for planting, see the section on soil management, page 11. If such preparations are not made, grubs may destroy the patch the first year since they cannot be controlled after the plants are set.

**Strawberry leaf roller.** The strawberry leaf roller is a small, greenish-brown caterpillar with a brown head. As its name indicates, it rolls one portion of the leaf over upon the other and feeds within this protecting fold (Fig. 18). It is very active when disturbed.

Normally the leaf roller is not a serious problem and can be adequately controlled by malathion as recommended on page 44. If it develops despite the malathion, apply a 5-percent TDE dust at 40 pounds an acre (see Table 4). TDE is specifically effective against this insect.

Right — A leaf typically folded by the strawberry leaf roller. Left — The same leaf held open to show the larva. *(Courtesy Missouri Agricultural Experiment Station)* (Fig. 18)

**Strawberry leaf beetle.** The strawberry leaf beetle is a small, brown or black, oval-shaped beetle about 1/8 inch long. Most of the damage is done by the mature form of the insect. The adult leaf beetles riddle the leaves with "shot holes," beginning their work as soon as growth commences in the spring. A second generation matures late in the summer and again injures the plants seriously.

Control is effected by spraying or dusting with malathion as recommended on page 44. Since the mature beetles hibernate in wasteland, such cover near strawberry beds ought to be burnt over during the winter or early spring if this pest continues to be serious. Old strawberry plantings nearby should also be kept clean. This is especially important in large plantings.

**Tarnished plant bug and stink bug.** The adult tarnished plant bug is about 1/5 inch long and colored an inconspicuous dull yellow or green, mottled with reddish brown. The group of insects called the stink bugs is composed of many different species, most of which are rather general plant feeders. Many of them infest strawberry plantings. The different species of stink bugs vary from 1/2 to 3/4 inch long.

Their coloring varies from a light green to a light brown. Both the tarnished plant bug and the stink bugs have a wide range of food plants and are responsible for most of the catfacing on peaches. The adults puncture young strawberry fruits, causing them to develop unevenly, especially at the tip. These berries are called "buttons."

The spray or dust mixture recommended on page 44 for early bloom will reduce injury as much as 50 to 75 percent.

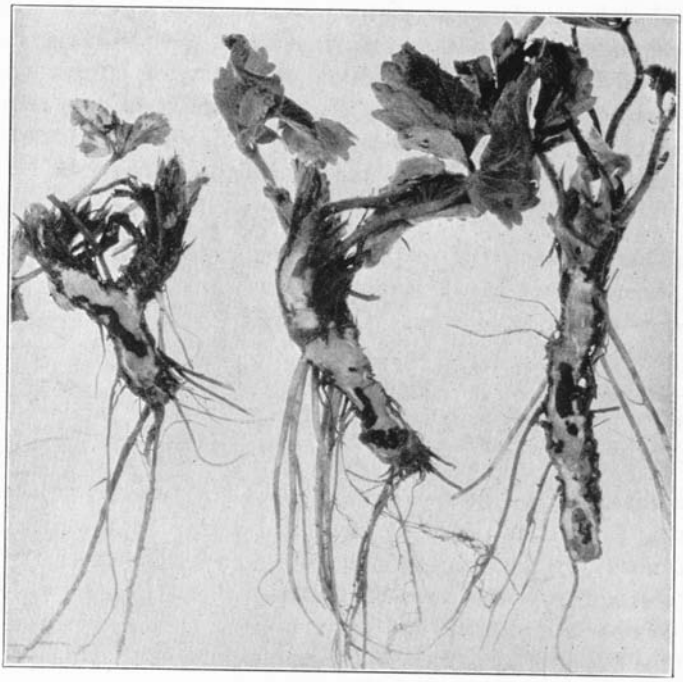
**Strawberry weevil** (or "clipper"). The strawberry weevil, a small, reddish-brown snout beetle, about 1/10 inch long, appears just as the strawberry begins to blossom. The female beetle punctures the bud and deposits an egg within it. She then girdles the fruiting stalk below the injured bud, causing it to droop and fall.

The spray or dust combination recommended on page 44 for use during early bloom has been effective in controlling this insect.

**Strawberry crown girdler or root weevil.** Reports of damage by this insect have come from southern and western Illinois. Injury is caused mostly by the small, white, legless grubs, which emerge from their hibernating places near the roots of the strawberry plants as warm weather approaches, and begin to feed on the crowns. At the same time the beetles gather in the patch, and egg laying begins on the roots of the plants. The beetles cannot fly, as their wing covers are grown together. The eggs soon hatch into grubs. There may be two broods a year in Illinois.

For chemical control, use the spray or dust mixture recommended on page 44 for use during early bloom. Control also depends on adequate preparation of the soil (see page 11).

**Strawberry crown borer.** Outbreaks of the strawberry crown borer, an insect native to the upper Mississippi valley, occur occasionally in widely scattered sections of Illinois and result in considerable damage. Most of the injury is caused by the white, thick-bodied grubs, which are about ⅕ inch long when full grown. The adult is a reddish-brown snout beetle about ⅙ inch long, which hibernates in the soil or under litter in or near the patch. In early spring, eggs are laid in the plant near the surface of the ground. Egg laying may continue up to nearly the end of June. On hatching, the grub works down through the crown, and by maturity may have eaten out most of the contents (Fig. 19). Sometimes only the shell is left if several grubs have been at work on one plant. After maturity in midsummer, the grubs transform to beetles, which remain in the burrows in the plant crown for several weeks before they eat their way out. The beetles go into



**These strawberry crowns have been seriously damaged by strawberry crown borers. *(Courtesy Illinois State Natural History Survey)* (Fig. 19)**

hibernation when winter approaches. Only one brood is produced each year. Infested plants are so weakened that they either die or produce very little new runner growth.

If any borer damage occurs, the use of insecticides as suggested on page 44 during the early spring may have an effect in reducing the population of the adult beetles. If an infestation develops, do not allow the bed to fruit more than two years.

New beds should not be nearer than 350 yards from old beds, for the beetles crawl as far as 300 yards. They do not fly because their wing covers are grown together. Keep cinquefoil (or fivefinger), which these insects also live on, from growing near strawberry beds.

**Strawberry rootworm.** Grubs of several species of small, copper-colored beetles, often very abundant in older beds, feed on strawberry roots. The adults feed on the foliage. The general spray suggested on page 44 for use during early bloom may help control this insect.

**Strawberry root louse.** The dark bluish-green aphids of the root louse hatch from shining black eggs on the leaves and stems of the strawberry plant early in the spring. They are often found by the brown cornfield ant and carried down to the strawberry roots, where they feed on the plant sap. Infested plants lose vigor, and their berries do not mature properly.

The general use of insecticides as suggested on page 44 will help control this insect. When setting out a new bed on the same ground where a root louse infestation has occurred, follow the preplanting recommendations given on page 11.

**Cutworms.** When strawberry plants have been cut off just at or below the surface of the ground early in spring, the damage may have been caused by cutworms. These insects are small, smooth, ground-colored caterpillars about an inch long. They hide just below the surface of the ground during the day and forage at night. There are at least a hundred different species of cutworms in Illinois, but most of them can be killed through the use of a poison bran bait.

*Poison bran bait.* — A formula for poison bran bait suitable for use on a small strawberry patch is 1 quart of bran or middlings, 1 teaspoonful of paris green, and 1 tablespoonful of cheap molasses, with sufficient water to moisten the bran. When injury from cutworms is severe, quicker results are possible if the poison mixture is made sweeter by doubling the amount of molasses. Scatter the bran evenly over the patch just at dusk and do not put it in lumps or windrows.

Directions for mixing and for using this mixture on a large scale are as follows: Add 2 quarts of blackstrap or other cheap molasses to 3 gallons of water and mix thoroughly. Stir in 1 pound of paris green, and add 25 pounds of bran, mixing the bran with the water and molasses until all of it has been moistened. If the mash is sloppy, add more bran until it is just thick enough to hold together when tightly squeezed in the hand. This mixture should be scattered over infested fields at the rate of about 8 to 10 pounds an acre.

The use of the insecticides recommended on page 44 will also help control cutworms.

**Spittlebugs.** White, frothy, irregular masses ½ inch or more in diameter covering small green insects sometimes appear on the stems and leaves of strawberries. The insects are known as spittlebugs because of their peculiar spittle-like covering.

The insects live over winter in the egg stage. The nymphs appear in April or May and complete their development in 5 to 8 weeks. Only

one generation occurs each year. The eggs are laid during the fall months. This insect has never been serious in Illinois but is present and commonly observed. The early-bloom insecticide spray probably helps to kill the young nymphs before they have a chance to protect themselves. Once the spittle is formed, the insects are difficult to reach.

**Two-spotted spider mite.** The two-spotted spider mite (the common red spider) sometimes attacks strawberry plants. Since the chlorinated hydrocarbon insecticides have come into use, many of the natural enemies of mites have been destroyed, and they have become serious in many plantings. The adult is quite small, measuring approximately 1/50 inch in length. In color it varies from pale greenish yellow to dark crimson, usually marked with dark spots, one on each side of the body. The length of the life-cycle varies with temperature, but normally a new generation is produced every 2 weeks.

When mites need control, use either Kelthane or Trithion with the regular insecticide and fungicide applications.

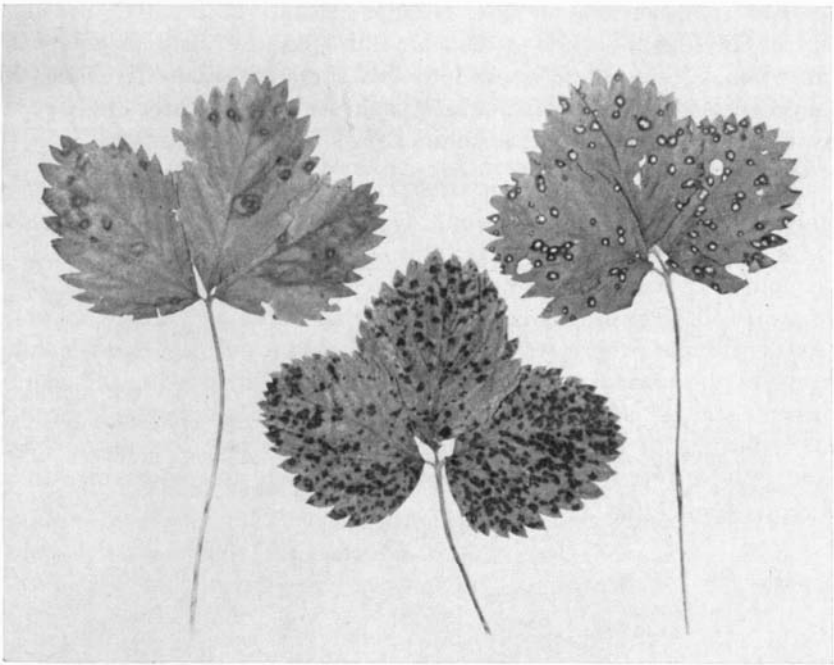
## DISEASES

Many diseases interfere with the normal development of strawberry plants. A grower should attempt to study these diseases so that he can recognize them if they do occur. Space in this circular does not permit detailed discussions of the various diseases, but for further information see *Diseases of Fruit Crops* by H. W. Anderson (McGraw-Hill Publishing Co., New York, 1956).

**Strawberry leaf diseases.** Three leaf diseases can cause severe damage to strawberries in Illinois when climatic conditions favor their development: leaf spot, leaf scorch, and leaf blight. Each may appear alone or with the others on a leaf or plant and each may greatly reduce plant vigor and yield.

*Strawberry leaf spot* is caused by a fungus known as *Mycosphaerella fragariae.* It infects the leaves, petioles, fruit, and pedicels, but is serious mainly on the leaves, causing a circular white spot with a purplish border (Fig. 20). Cool, wet weather favors this disease. It may then cause fruits to be abnormal and show a black seed condition.

*Leaf scorch* is caused by a fungus known as *Diplocarpon earliana.* It is primarily a leaf disease but may also infect the calyces, petioles, and pedicels. In the early stages of infection, small purple spots appear on the upper surface of the leaves (Fig. 20). Each spot may enlarge



**Leaf symptoms of three strawberry diseases. Left, leaf blight; center, leaf scorch; and right, leaf spot. (Fig. 20)**

until it resembles a slight spot of tar. Finally the spots coalesce, covering the entire leaf. This disease may develop from early spring until late fall whenever moisture is available. It is now considered the most serious strawberry leaf disease in Illinois.

*Leaf blight* is caused by a fungus known as *Dendrophoma obscurans*. It is as common as the two leaf diseases just discussed but normally does not do as much damage. It infects primarily the leaves and calyces and during wet, warm weather may cause a stem-end rot of the fruit.

Leaf blight looks distinctly different from leaf spot or leaf scorch (Fig. 20). A typical spot is at first purple but later develops into a dark brown center encircled by a light brown area, which, in turn, is surrounded by a purple ring. A V-shaped infection is most common, with the wide part of the V at the leaf margin. Except on very susceptible varieties this disease does not appear until early summer. In Illinois it is primarily of importance on either new or renovated plants as they are developing during the summer and fall period.

Control of the leaf diseases is quite difficult. Both scorch and spot infect only the underside of the leaf; thus sprays or dusts (see page 44 and Table 5) must be applied to this surface for effectiveness. In addition, none of the commercial fungicides is sufficiently effective to control these diseases when conditions are ideal for infection.

**Red stele root rot.** This is a root rot caused by the fungus *Phytophthora fragariae.* It is a serious disease of strawberries since most of the desirable commercial varieties are highly susceptible to it. The symptoms first appear in the spring from about full bloom to the harvest period. The leaves become somewhat rolled and wilted at first. As the disease progresses, the leaves take on a dull lead cast in contrast to the normal bright-green color of healthy leaves, the plants become stunted, and the fruits dry up. Infected roots show a browning or reddening of the stele, or central core. The root tips usually die, and only a few of the small rootlets develop as compared with a normal plant (Fig. 21).

Symptoms of red stele root rot. Left — plant on left showing effects of the disease. Note the stunted appearance of the plant and the absence of small feeding roots as compared with the normal plant on the right. Center and right — strawberry roots cut lengthwise to expose the central core or stele. Healthy root on the right with light-colored stele and infected root in the center with reddened stele. (Fig. 21)

In a cool, wet spring, red stele may appear to be fairly well distributed over the entire strawberry patch. Normally, however, it is prevalent only in the lower or poorly drained areas of the field. Usually when plants start wilting and dying in the lower portions of the strawberry patch, the disease is red stele.

To minimize red stele, plant disease-free stock, preferably of resistant varieties, and avoid poorly drained sites (see page 5) and contaminated soils. Once the fungus is established in the soil, it may remain viable for at least 12 years regardless of which crop rotation is used.

The only practical method of controlling red stele that has been found so far is the use of resistant varieties. A number of resistant varieties have been developed (see Table 1, page 11).[1] The fungus causing red stele has been found to have different races and these races differ in their ability to infect different varieties. A variety that is resistant to red stele in one area may therefore be susceptible in another. For practical purposes, Illinois strawberry growers should be concerned about only the common or A-1 race. Race A-3 has been found in Illinois in two different fields, but its distribution is believed to be extremely limited.

**Verticillium wilt.** This is a vascular disease caused by the fungus *Verticillium albo-atrum.* The symptoms of this disease that are visible above ground cannot be easily differentiated from the symptoms of red stele and other root diseases. When the disease is not serious, an occasional plant will die, or several plants scattered over a patch may wilt down and die. When the disease is serious, the entire patch will die out. Verticillium does not respond to drainage or elevation of the planting site as does red stele. There is no practical chemical control available for this disease. It is not wise to plant strawberries on land which has previously grown any of the solanaceous plants such as potato, tomato, and pepper. These are particularly susceptible to Verticillium wilt and the soil may become contaminated with wilt inoculum. This disease is well established in Illinois.

**Gray mold.** This is one of the most common strawberry diseases. It is caused by a fungus known as *Botrytis cinerea.* The gray mold fungus spends the winter in old stalks or other vegetative debris either

[1] Other red stele resistant varieties are available. For a complete list of them, write to Department of Plant Pathology, University of Illinois, Urbana, Illinois.

**Gray mold on strawberries. Note fuzzy covering of rotted fruit. (Fig. 22)**

in the strawberry patch or along adjoining fence rows. As spring approaches and the first strawberry blossoms appear, the wind may disseminate thousands of spores over the strawberry bed. These spores will infect the stems, blossoms, and fruit. Yield is greatly cut if a high percentage of new blossoms become infected. As the name implies, the diseased plant tissue is covered with a light gray, fluffy mold which actually is composed of spores. These spores cause more disease.

As the berries mature, they become more susceptible to infection. During very rainy and humid seasons, gray mold may destroy the entire crop. Often the disease is not detected until berrypicking time, when a large number of rotten berries are found. Within 48 hours after the good berries are picked, they may become a mass of rotted fruits (Fig. 22).

For control, use the fungicides as recommended on page 44.

**Rhizopus rot.** This fruit rot is caused by the fungus *Rhizopus stolonifer*. It is primarily a post-harvest disease which develops on the fruit after it is picked. The rot is commonly called "leak" since the juice from diseased berries leaks out of the bottom of the container. Because the organism is found on all types of fruit and vegetative

debris, it may occur under field conditions when the weather is ideal for its development.

Rhizopus rot is characterized by the very soft, watery tissue at the surface of the fruit and the ready exudation of the juice on slight pressure. In packaged fruit this rot may be confused with gray mold since the entire surface of the package soon becomes covered with a white, fluffy mycelial mat. Black fruiting bodies may be seen scattered over the surface of this growth, and this distinguishes it from the gray mold disease.

There is no evidence that a fungicide program is effective in reducing this disease. Sanitation is one of the best means of keeping it at a minimum. The fruit should be handled carefully to prevent bruises, and culls should not be allowed to accumulate. Precooling to 50° F. or lower helps control rhizopus.

**Minor fungus diseases.** Other diseases are reported occasionally in Illinois. Cortical root rot has been reported and a species of Rhizoctonia has been considered one of the pathogens causing the damage. This is commonly referred to as a root rot complex since many pathogens have been found associated with this type of damage. Another disease known as leather rot, caused by the fungus *Phytophthora cactorum,* is commonly found in Illinois. Berries in close proximity with the soil may turn brown and appear water soaked. But instead of becoming soft, as happens with most fruit rots, the infected area becomes hard and leathery. This disease will attack fruits at all stages of maturity.

No control is known for either cortical root rot or for leather rot.

Powdery mildew is another minor disease that may become serious during high humidity, heavy dews, or misting and moderately cool temperatures. This disease causes the edges of affected leaves to curl upward, exposing the undersurface. The powdery growth develops on all sides of the leaves and stem. A serious infection usually interferes with the maturation of the fruit. It is likely to be more prevalent in the northern third of the state.

If powdery mildew becomes a problem, use sulfur sprays or dusts. These may be combined with the regular chemical treatment or applied separately, whichever is more convenient.

**Virus diseases.** Several virus diseases are known to cause damage to strawberry plants. Such diseases may produce either leaf mottling, mild yellow-edge, crinkle, vein chlorosis, leaf curl, or dwarfing. As it is impossible to cure an established virus infection, all infected plants should be destroyed as soon as they are seen. Sucking insects such as

aphids spread virus diseases from plant to plant. For this reason it is important to apply enough of some insecticide such as malathion to the plants during the growing season to keep these insects under control should they become prevalent.

All reliable nurseries now sell only substantially virus-free plants. Thus it is possible to make new plantings substantially free of virus and, for all practical purposes, to eliminate the virus problem. Of course, diseases can be brought in from wild strawberry or infected volunteer plants. For this reason it is still important to keep the insects under control.

**Nematodes.** Several nematodes attack the strawberry and cause serious damage. At this time, however, as far as we know, nematodes have not been a problem in Illinois.

**PUBLICATIONS ON STRAWBERRY CULTURE**

**Books.** A number of books have been published that deal wholly or in part with strawberry culture. Among these are:

Fruit Science — Childers

Small Fruits for Your Home Garden — Clarke

Small Fruit Culture — Shoemaker

The How-To Book on Strawberries — Wyld

**Pamphlets.** Many state agricultural colleges publish information on strawberry growing, available for free distribution upon request. Also, a number of publications on the subject can be obtained from the Office of Information, U.S. Department of Agriculture, Washington 25, D.C. These include:

Reducing Virus and Nematode Damage to Strawberry Plants (Leaflet No. 414)

Strawberry Varieties in the United States (Farmers' Bul. 1043)

Preparing Strawberries for Market (Farmers' Bul. 1560)

Strawberry Diseases (Farmers' Bul. 2140)

The following additional publications may be obtained from the Department of Plant Pathology, University of Illinois, Urbana, Illinois:

Strawberry Red Stele Root Rot (Plant Disease No. 701)

Strawberry Leaf Spot Diseases (Plant Disease No. 702)

Gray Mold of Strawberries (Plant Disease No. 704)

Strawberries — Spray and Dust Guide (Fruit Leaflet No. 1)

Chemical Weed Control in Strawberry Plantings (Fruit Growing No. 12) Available from the Department of Horticulture at Urbana.

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